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Oshima

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(54) **FLOW RATE ADJUSTING VALVE**

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F16K 1/36 (2006.01)
F16K 35/02 (2006.01)

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CPC ***F16K 31/05*** (2013.01); ***F16K 1/36*** (2013.01)

(58) **Field of Classification Search**
CPC F16K 31/05; F16K 35/027; F16K 1/38; F16K 1/50
USPC 251/129.03
See application file for complete search history.

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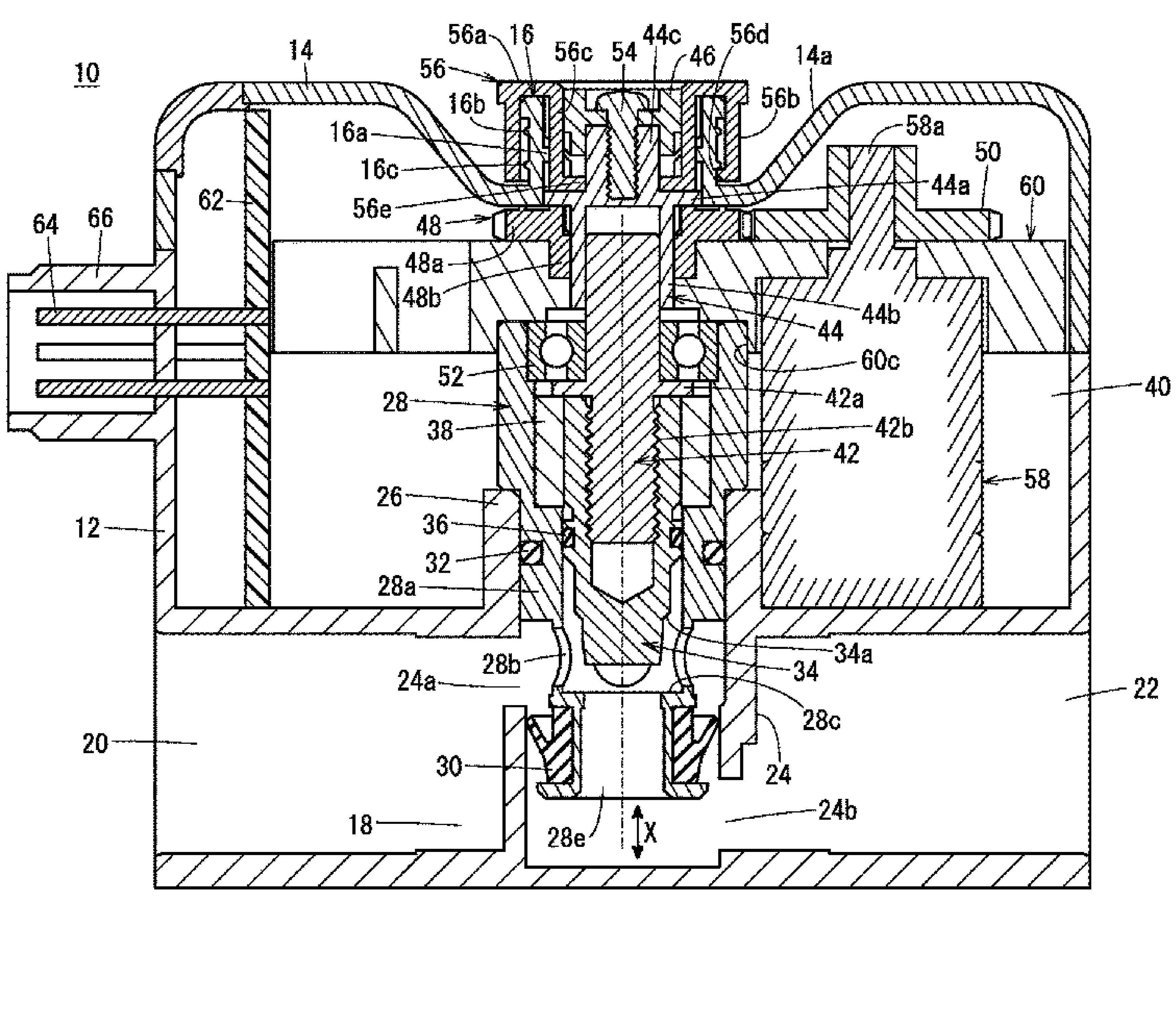
(57) **ABSTRACT**

A flow rate adjusting valve, in which a needle valve is arranged so as to face a fluid passage of a main body, is equipped with a handle configured to enable a rotational operation to be performed manually, an electric motor configured to be operated remotely, and a motive power transmission mechanism that selectively switches between a rotational operating force of the handle and a driving force of the electric motor, and to transmit the force to the needle valve. The switching is performed by causing the handle to be moved in a direction of an axis of rotation.

8 Claims, 6 Drawing Sheets



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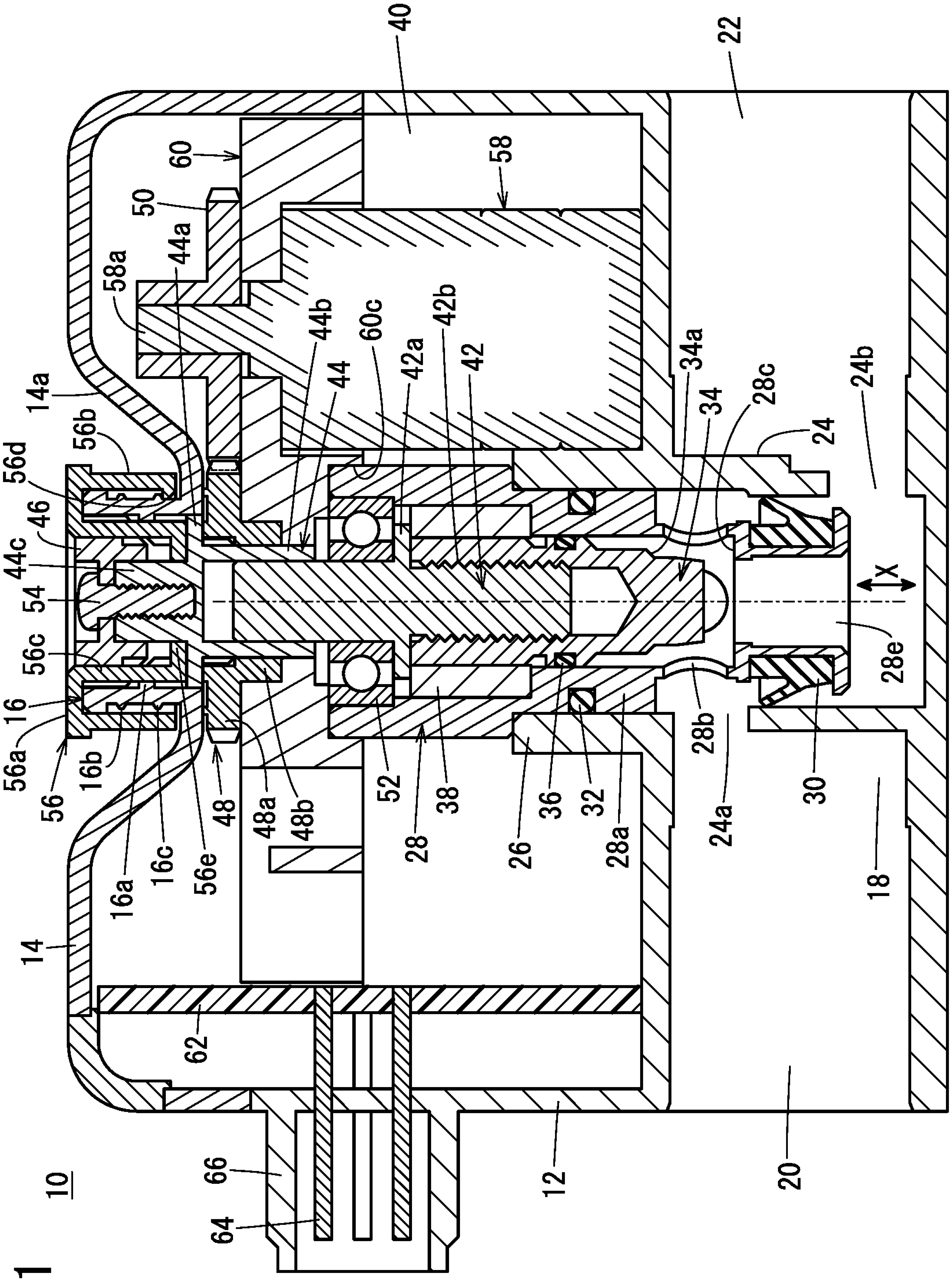
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FIG. 1

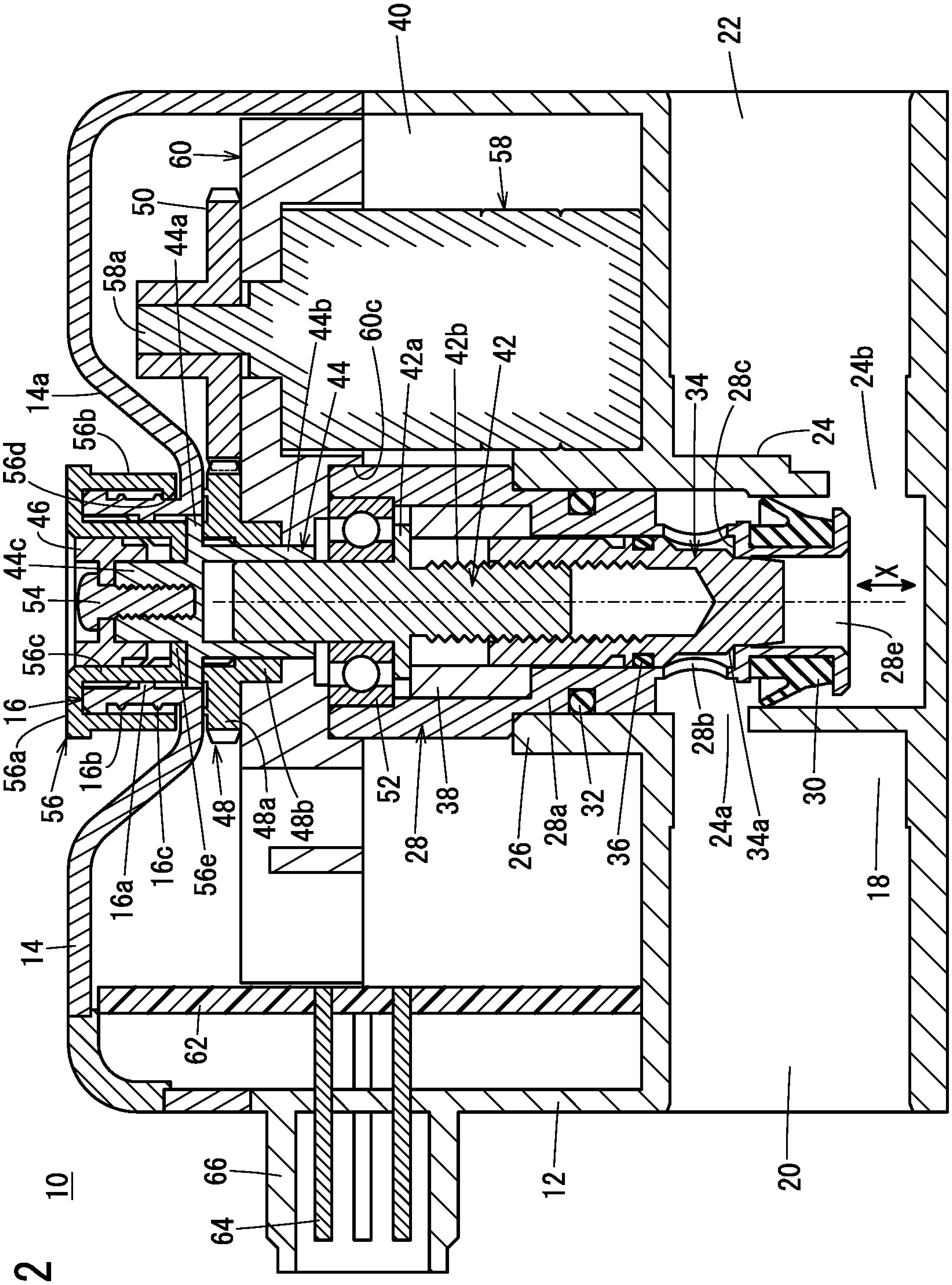
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FIG. 2

FIG. 3

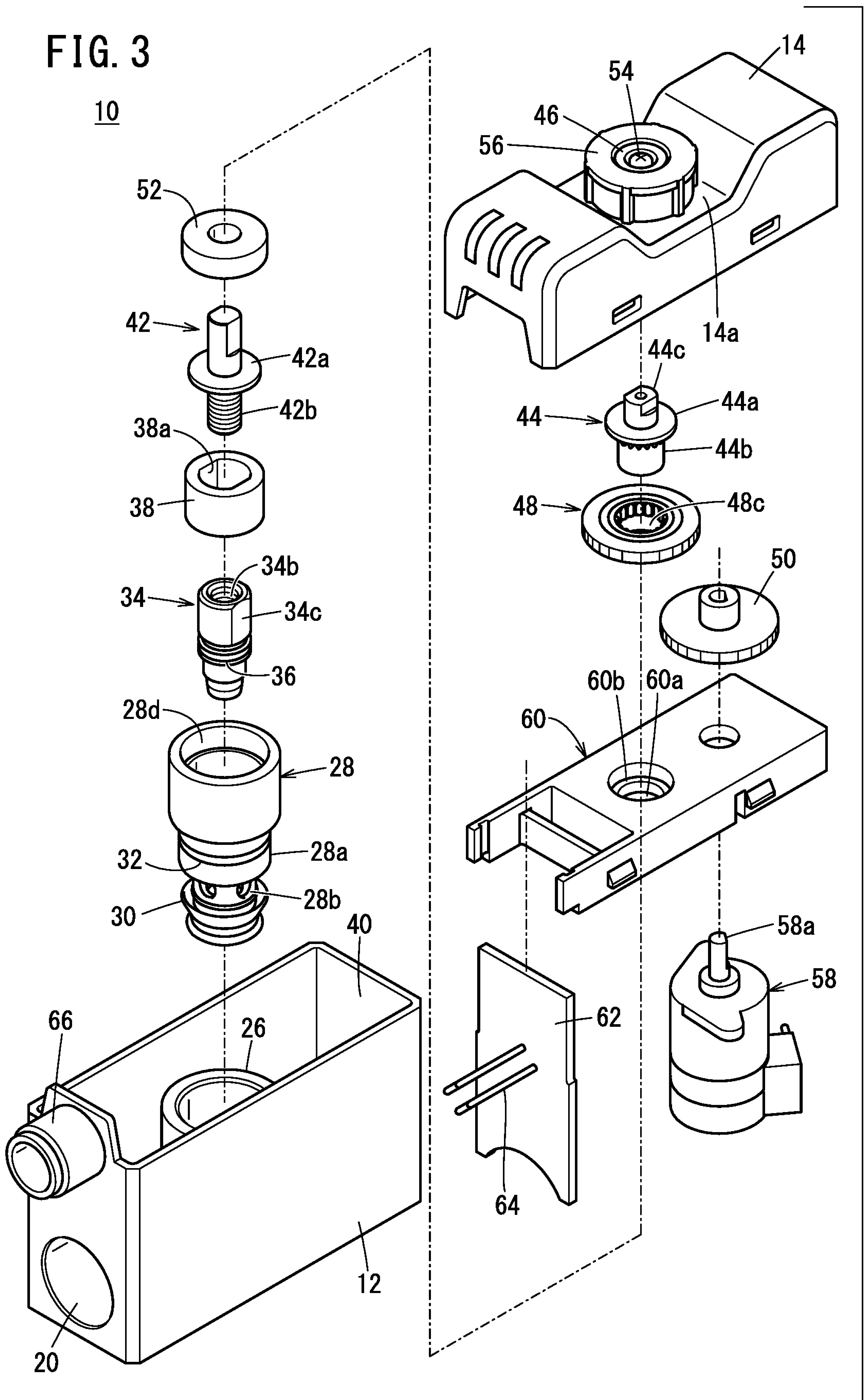
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FIG. 4

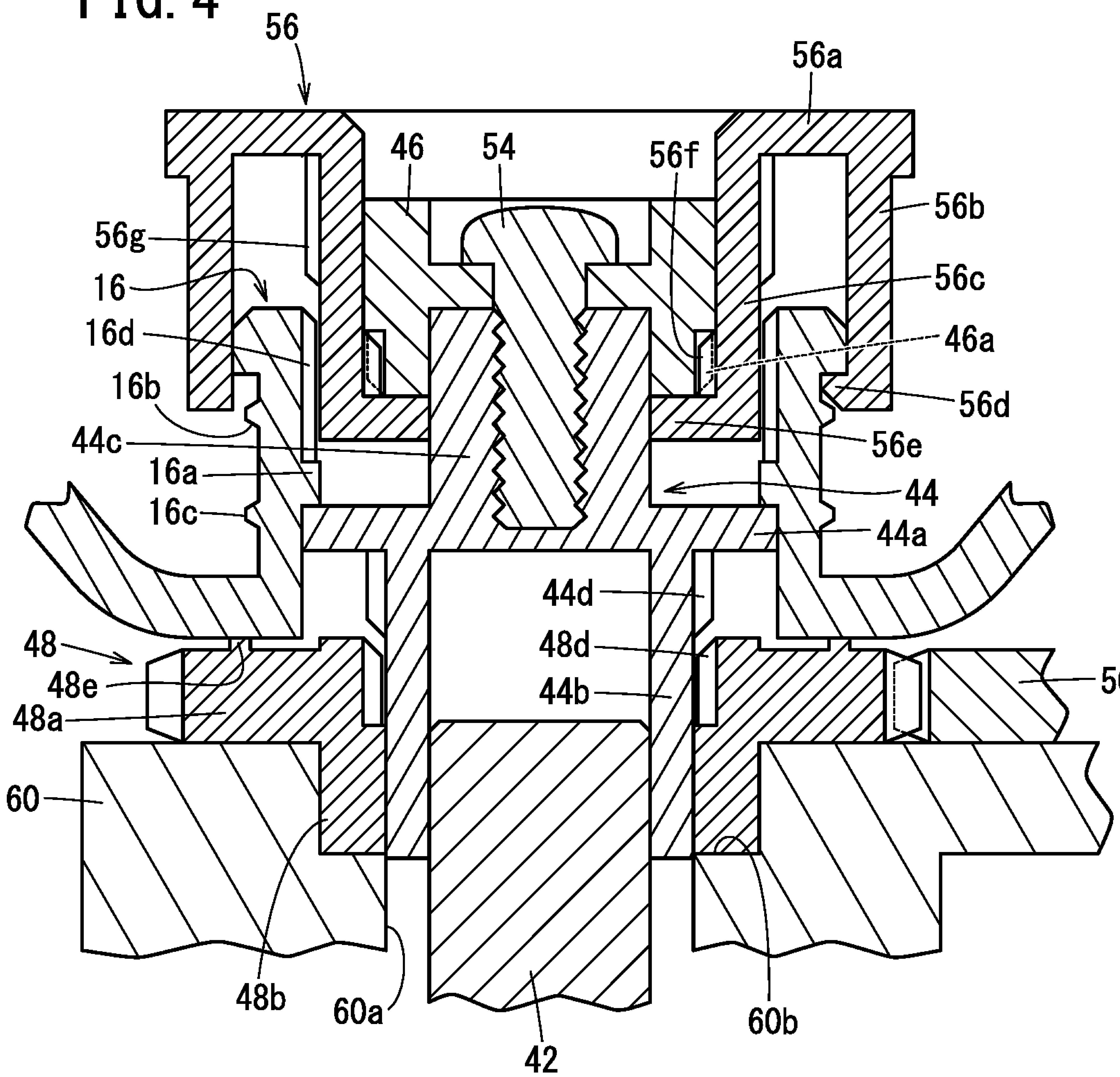
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FIG. 5

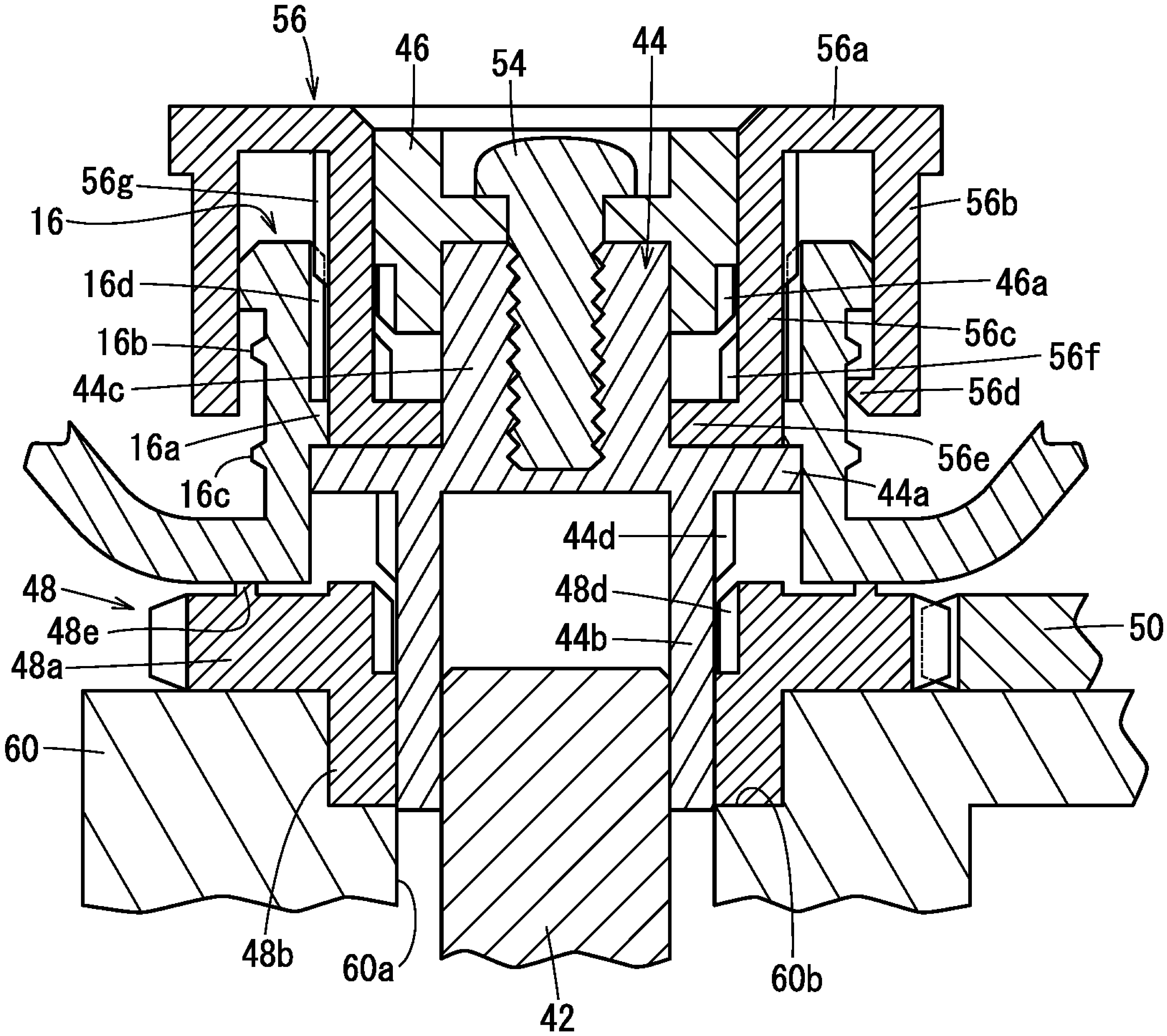
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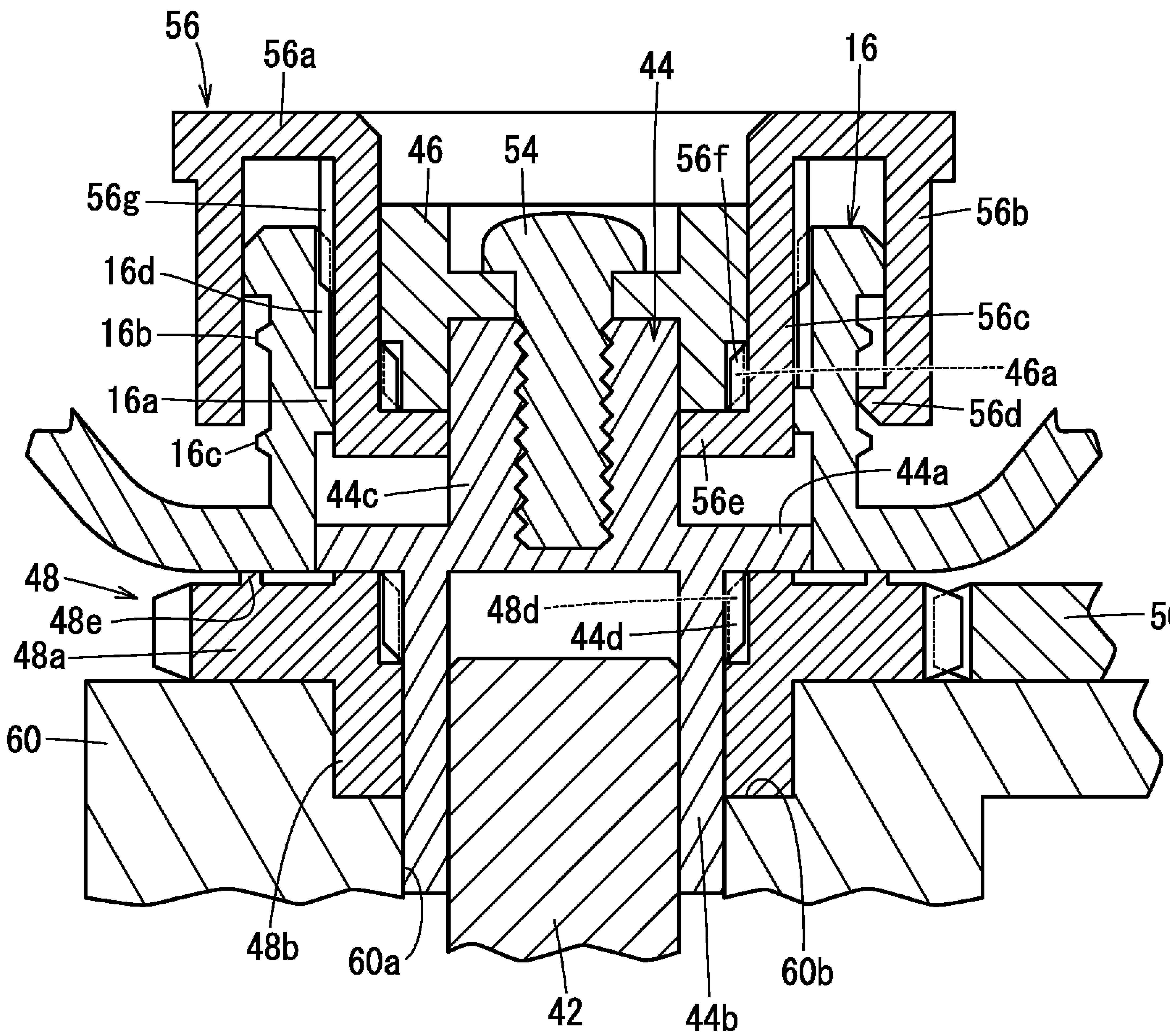
FIG. 6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FLOW RATE ADJUSTING VALVE

CROSS-REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2020-189945 filed on Nov. 16, 2020, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a flow rate adjusting valve that adjusts a flow rate in a fluid passage.

Description of the Related Art

Conventionally, as a means for adjusting the speed of a fluid pressure cylinder, a flow rate adjusting valve (speed controller) that is capable of adjusting a flow path area by a manual operation has been known. The flow rate adjusting valve is disposed, for example, in a flow path connecting a fluid pressure cylinder and a fluid supply source, or in a flow path connecting the fluid pressure cylinder and a discharge port.

Further, as shown in JP 5061258 B2, an electric needle valve is also known in which a valve opening degree is adjusted by an electric motor, so as to enable the flow rate of a fluid supplied to an actuator to be remotely controlled.

SUMMARY OF THE INVENTION

Even in the case of such a flow rate adjusting valve in which the valve opening degree is adjusted by driving an electric motor by remote control, when the equipment is started up, it is necessary to manually adjust the degree of the valve opening, and to confirm operation of the equipment or the like. In general, an assembly process of the production equipment is carried out by a procedure of assembling a machine body, providing pneumatic piping and electrical wiring, and downloading a program to a PLC or the like. Remote control signals can be transmitted to the electric motor only after downloading of the program has been completed. Confirmation of operations while the equipment is being driven must be carried out at an earlier stage, and at that time, such a confirmation must be performed manually.

Further, in the case of remote control via a PLC, a system operator or a software engineer is generally required. There are also cases in which a person performing maintenance of the equipment does not possess the necessary capability to operate the equipment remotely. If the degree of opening of the flow rate adjusting valve cannot be adjusted manually, cooperation of a system operator or a software engineer must be sought, which is troublesome and time consuming.

Of course, it is possible to provide a manual operating unit for the flow rate adjusting valve that drives the electric motor to adjust the valve opening degree. However, in the case of using a small-scale electric motor equipped with a speed reducing gear having a large speed reducing ratio, in a state in which the operating unit is connected to the electric motor on a driven side of the speed reducing gear, a situation occurs in which manual operation thereof is difficult.

As described above, there is a demand for a flow rate adjusting valve in which a valve opening degree is capable of being adjusted both manually and by an electric motor. However, practical implementations thereof have not yet been adequately developed. The present invention has the object of solving the aforementioned problem.

A flow rate adjusting valve according to the present invention is one in which a needle valve is arranged so as to face a fluid passage of a main body, the flow rate adjusting valve including a handle configured to enable a rotational operation to be performed manually, an electric motor configured to be operated remotely, and a motive power transmission mechanism configured to selectively switch between a rotational operating force of the handle and a driving force of the electric motor, and to transmit the force to the needle valve, wherein the switching is performed by causing the handle to be moved in a direction of an axis of rotation.

According to the above-described flow rate adjusting valve, regardless of the specifications of the electric motor, manual operation of the handle can be easily realized. Further, since the rotational operating force of the handle and the driving force of the electric motor can be selectively switched by way of a push-pull operation of causing the handle to be moved in the direction of the axis of rotation, ease of operation is satisfactory. Furthermore, since the handle is not rotated together therewith by the electric motor, the safety of on-site workers is assured.

The flow rate adjusting valve according to the present invention is also equipped with a motive power transmission mechanism that selectively switches between the rotational operating force of the handle and the driving force of the electric motor, and transmits the selected force to the needle valve. Therefore, regardless of the specifications of the electric motor, manual operation of the handle can be easily realized, and the safety of on-site workers is assured. Further, since the aforementioned switching can be performed by a push-pull operation of causing the handle to be moved in the direction of the axis of rotation, ease of operation is satisfactory.

The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings, in which a preferred embodiment of the present invention is shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view of a flow rate adjusting valve according to an embodiment of the present invention, when a handle is in a lower limit position, and the valve opening degree is maximum (a fully open state);

FIG. **2** is a cross-sectional view of the flow rate adjusting valve shown in FIG. **1**, when the handle is in the lower limit position, and the valve opening degree is zero (a fully closed state);

FIG. **3** is a view in which the flow rate adjusting valve shown in FIG. **1** is expanded into parts or groups of parts;

FIG. **4** is a cross-sectional view of principal components of the flow rate adjusting valve shown in FIG. **1**, when the handle is in an upper limit position;

FIG. **5** is a cross-sectional view of principal components of the flow rate adjusting valve shown in FIG. **1**, in a state during which the handle is being pushed down from the upper limit position to the lower limit position; and

FIG. **6** is a cross-sectional view of principal components of the flow rate adjusting valve shown in FIG. **1**, in a state during which the handle is being pulled upward from the lower limit position to the upper limit position.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A flow rate adjusting valve **10** according to an embodiment of the present invention is used to adjust the flow rate of a fluid such as compressed air or the like. In the following description, when the terms in relation to the up, down, left, and right directions are used, for the sake of convenience, such terms refer to the directions shown in the drawings, however, the actual arrangement of the respective component members is not necessarily limited to this feature.

As shown in FIGS. **1** and **3**, the flow rate adjusting valve **10** includes a main body **12**, a cover **14**, a valve seat body **28**, a needle valve **34**, a handle **56**, a stepping motor (electric motor) **58**, and a motive power transmission mechanism. The motive power transmission mechanism is a mechanism that selectively switches between a rotational operating force of the handle **56** and a driving force of the stepping motor **58**, and transmits the selected force to the needle valve **34**. Details of the motive power transmission mechanism will be described later. The stepping motor **58** has a non-illustrated speed reducing gear incorporated therein. According to the present embodiment, the stepping motor **58** is used as the electric motor, but other types of electric motors may also be used.

The box-shaped main body **12** includes an accommodating chamber **40** in which the stepping motor **58** and the motive power transmission mechanism are accommodated in cooperation with the cover **14**. The cover **14** is attached to a support frame **60**, which will be described later. An upper surface of the cover **14** is recessed downward at a position in proximity to a central location thereof in the longitudinal direction. The center of a bottomed surface of a recess **14***a* is open. A tubular handle supporting member **16** that rises upwardly from an open edge of the recess **14***a* is provided integrally with the cover **14**.

A lower part of the main body **12** includes a fluid passage **18** both ends of which are open, and which extends in a left and right direction. A first port **20** that opens on one end of the fluid passage **18**, and a second port **22** that opens on another end of the fluid passage **18** are respectively connected to non-illustrated external pipes. According to the present embodiment, a configuration is provided so that, by action of a later-described check valve **30**, the flow rate can be adjusted when the fluid flows from the first port **20** toward the second port **22**.

The valve seat body **28** and the needle valve **34** are arranged in a manner so as to intersect the fluid passage **18**. A cylindrical shaped guide wall **24** for guiding the fluid is arranged at a central location of the fluid passage **18** in the longitudinal direction. A central axis of the guide wall **24** is aligned with a central axis of the valve seat body **28** and the needle valve **34**. The guide wall **24** includes a first window portion **24***a*, which is formed at an upper location of a portion of the guide wall that is closer to the first port **20**. The guide wall **24** includes a second window portion **24***b*, which is formed at a lower location of a portion of the guide wall that is closer to the second port **22**. The first port **20** is connected to the second port **22** via the first window portion **24***a* and the second window portion **24***b*. The guide wall **24** extends into the accommodating chamber **40**, and the extended portion thereof constitutes a supporting wall **26** that supports the valve seat body **28**.

The tubular valve seat body **28** includes a supporting portion **28***a*, which is positioned at a central location of the valve seat body in the longitudinal direction. The supporting portion **28***a* is fitted and fixed to an inner side of the supporting wall **26** of the main body **12**. On the inner side of the valve seat body **28**, the needle valve **34** is inserted and arranged so as to be capable of moving in the X direction, which is the axial direction thereof. A distal end of the needle valve **34** faces toward the fluid passage **18**. The outer circumference of a portion of the needle valve **34** that is in proximity to a distal end of the needle valve has a tapered surface **34***a*.

A more downward location than the supporting portion **28***a* of the valve seat body **28** includes a plurality of lateral holes **28***b* that penetrate through the side wall of the valve seat body **28**. The valve seat body **28** further includes a valve seat **28***c* at a more downward location than the lateral holes **28***b*. The valve seat is capable of abutting against the tapered surface **34***a* of the needle valve **34**. In a state in which the needle valve **34** is separated away from the valve seat **28***c*, the first window portion **24***a* communicates with the second window portion **24***b* via the lateral holes **28***b* of the valve seat body **28** and a lower end opening **28***e* of the valve seat body **28**. As shown in FIG. **2**, in a state in which the needle valve **34** is placed in abutment against the valve seat **28***c*, communication between the first window portion **24***a* and the second window portion **24***b* via the lateral holes **28***b* of the valve seat body **28** and the lower end opening **28***e* of the valve seat body **28** is blocked.

A check valve **30**, which can be placed in pressure-contact with an inner circumference of the guide wall **24** of the main body **12**, is mounted on the outer circumference of a lower end part of the valve seat body **28**. The check valve **30** prevents the fluid from flowing from the first window portion **24***a* to the second window portion **24***b* through a gap between the lower end part of the valve seat body **28** and the guide wall **24**. The check valve **30** allows the fluid to flow through the aforementioned gap from the second window portion **24***b* to the first window portion **24***a*. In a state in which the needle valve **34** is placed in abutment against the valve seat **28***c*, flowing of the fluid from the first port **20** to the second port **22** is prevented. In a state in which the needle valve **34** is separated away from the valve seat **28***c*, the fluid flows from the first port **20** toward the second port **22** at a flow rate corresponding to a flow path area which changes in accordance with the separation distance thereof.

A cylindrical collar **38** that supports an upper end part of the needle valve **34** is fixed to an inner surface of the valve seat body **28** at a more upward location than the supporting portion **28***a*. An outer circumference of the needle valve **34** and an inner circumference of the collar **38** are equipped with two sets of flat surfaces **34***c* and **38***a* that abut against one another. Consequently, the needle valve **34** is supported by the collar **38**, in a manner so that rotation about a central axis is restricted, together with the needle valve **34** being capable of moving in the axial direction. According to the embodiment, the two sets of flat surfaces are used as a means for preventing the needle valve **34** from rotating with respect to the collar **38**. However, a means such as a set of flat surface portions (D-cuts), splines, or the like may also be used.

An annular seal member **32**, which abuts against an inner circumference of the supporting wall **26** of the main body **12**, is mounted on an outer circumference of the supporting portion **28***a* of the valve seat body **28**. Further, an annular needle packing **36**, which is placed in sliding contact with an inner circumference of the supporting portion **28***a* of the valve seat body **28**, is mounted on the outer circumference of the needle valve **34**. The fluid passage **18** is separated in an airtight manner from the accommodating chamber **40** by the seal member **32** and the needle packing **36**. Since the needle valve **34** is formed with a structure in which rotation about the central axis does not take place, the load applied to the needle packing **36** is reduced, and the durability of the needle packing **36** is enhanced.

The motive power transmission mechanism includes a feed screw **42**, a stem **44**, a handle holder **46**, a valve gear **48**, and a motor gear **50**. The rotational operating force of the handle **56** is transmitted to the needle valve **34** via the handle holder **46**, the stem **44**, and the feed screw **42**. The driving force of the stepping motor **58** is transmitted to the needle valve **34** via the motor gear **50**, the valve gear **48**, the stem **44**, and the feed screw **42**. Stated otherwise, the motive power transmission path between the handle **56** and the needle valve **34** is constituted by the handle holder **46**, the stem **44**, and the feed screw **42**. The motive power transmission path between the stepping motor **58** and the needle valve **34** is constituted by the motor gear **50**, the valve gear **48**, the stem **44**, and the feed screw **42**. Hereinafter, a description will be given in detail of the motive power transmission mechanism.

The feed screw **42** includes a flange **42***a* in a central location thereof in the longitudinal direction, and further includes a male screw **42***b* on an outer circumference at a more downward location than the flange **42***a*. The feed screw **42** is rotatably supported by a bearing **52** provided on an upper end opening **28***d* of the valve seat body **28**, at a more upward location than the flange **42***a*. An upper end of the feed screw **42** projects upwardly from the bearing **52**, and is fitted on an inner side of a later-described cylindrical portion **44***b* of the stem **44**.

The needle valve **34** includes a bottomed screw hole **34***b* that opens at the upper end of the needle valve **34**. A lower portion of the feed screw **42** is screwed-engaged with the screw hole **34***b*. The flange **42***a* of the feed screw **42** is arranged in a manner of being sandwiched between a lower surface of the bearing **52** and an upper surface of the collar **38**. Consequently, movement of the feed screw **42** in the X direction, which is the axial direction, is restricted. When the feed screw **42** is rotated, the needle valve **34**, the rotation of which about the central axis is restricted, moves in the axial direction.

The stem **44** includes a plate-shaped flange portion **44***a* that extends in a horizontal direction, a cylindrical portion **44***b* extending downward from the flange portion **44***a* and the distal end of which is open, and a protruding portion **44***c* that protrudes upwardly from the flange portion **44***a*. The cylindrical portion **44***b* of the stem **44** is connected to the upper end part of the feed screw **42** by a predetermined means for preventing rotation. Consequently, the feed screw **42** rotates integrally with the stem **44**, and the stem **44** is capable of moving relative to the feed screw **42** in the X direction, which is the axial direction. According to the present embodiment, two sets of flat surface portions are used as the means for preventing rotation, but one set of flat surface portions (D-cuts), splines, or the like may also be used.

Upward movement of the stem **44** is restricted by the flange portion **44***a* of the stem **44** coming into abutment against a step portion **16***a*, which is disposed in a projecting manner from an inner circumference of the handle supporting member **16** of the cover **14**. An outer circumference of the upper end part of the cylindrical portion **44***b* of the stem **44** is equipped with splines **44***d* that engage with later-described splines **48***d* of the valve gear **48** (see FIG. **4**). The handle holder **46** is fixed by a mounting screw **54** to the protruding portion **44***c* of the stem **44**. An outer circumference of the handle holder **46** includes splines **46***a* that engage with later-described first splines **56***f* of the handle **56** (see FIG. **5**).

The handle **56** includes an annular seat portion **56***a*, an outer tubular portion **56***b* extending downward from an outer circumferential part of the seat portion **56***a*, and an inner tubular portion **56***c* extending downward from an inner circumferential part of the seat portion **56***a*. A lower end of the outer tubular portion **56***b* is equipped with a rib **56***d* that projects inwardly in the radial direction. A lower end of the inner tubular portion **56***c* is equipped with a flange **56***e* that extends inwardly in the radial direction. As shown in FIG. **4**, an inner circumference of the inner tubular portion **56***c* in proximity to the lower end is provided with first splines **56***f* that engage with the splines **46***a* of the handle holder **46**. Further, an outer circumference of the inner tubular portion **56***c* in proximity to the upper end is provided with second splines **56***g* that engage with splines **16***d* provided on the inner circumference of the handle supporting member **16** of the cover **14**.

The handle **56** is capable of being subjected to a push-pull operation, and is capable of moving in the X direction (upper and lower direction), which is the direction of the axis of rotation thereof, between the upper limit position (upward end of movement) and the lower limit position (downward end of movement) as will be discussed below. When the upper surface of the flange **56***e* of the handle **56** abuts against the lower surface of the handle holder **46** and the handle holder **46** is pulled upward, the flange portion **44***a* of the stem **44** which moves integrally with the handle holder **46** abuts against the step portion **16***a* of the handle supporting member **16**. As a result, the handle **56** arrives at the upper limit position (see FIG. **4**).

The handle supporting member **16** enters into a space between the inner tubular portion **56***c* and the outer tubular portion **56***b* of the handle **56**. When a lower surface of the seat portion **56***a* of the handle **56** abuts against an upper end of the handle supporting member **16**, the handle **56** arrives at the lower limit position (see FIG. **1**). When the handle **56** is at the upper limit position, the handle **56** protrudes significantly upward from the cover **14**, whereby the rotational operation becomes easy to perform. When the handle **56** is at the lower limit position, the handle **56** enters into the recess **14***a* of the cover **14**.

When the handle **56** is moved upward (in a first direction), the first splines **56***f* of the inner tubular portion **56***c* engage with the splines **46***a* of the handle holder **46**. As a result, the handle **56**, the handle holder **46**, and the stem **44** can be rotated together in an integral manner. Further, when the handle **56** is moved to the upper limit position, engagement between the second splines **56***g* of the inner tubular portion **56***c* and the splines **16***d* of the handle supporting member **16** is released.

When the handle **56** is moved downward (in a second direction), engagement between the first splines **56***f* of the inner tubular portion **56***c* and the splines **46***a* of the handle holder **46** that is integral with the stem **44** is released. When the handle **56** is moved downward, the second splines **56***g* of the inner tubular portion **56***c* engage with the splines **16***d* of the handle supporting member **16**, and rotation of the handle **56** is prevented. Further, when the second splines **56***g* of the inner tubular portion **56***c* start to engage with the splines **16***d* of the handle supporting member **16**, the flange **56***e* of the inner tubular portion **56***c* comes into abutment against the flange portion **44***a* of the stem **44**. Due to the flange **56***e* pushing the flange portion **44***a* downward, the stem **44** moves downward together with the handle **56**.

The outer circumference of the handle supporting member **16** of the cover **14** is equipped with a first rib **16***b* and a second rib **16***c* that are arranged at a predetermined interval in the vertical direction. The first rib **16***b* and the second rib **16***c* engage with the rib **56***d* of the outer tubular portion **56***b* of the handle **56**. When the handle **56** is pulled up to the upper limit position, the rib **56***d* of the handle **56** snap-engages with the first rib **16***b* of the handle supporting member **16**. When the handle **56** is pushed down to the lower limit position, the rib **56***d* of the handle **56** snap-engages with the second rib **16***c* of the handle supporting member **16**. Accordingly, unless an external force is applied thereto, the handle **56** that has reached the upper limit position or the lower limit position is stably retained at the upper limit position or the lower limit position.

In the accommodating chamber **40**, the support frame **60** which serves to support the stepping motor **58** is arranged in the horizontal direction. The support frame **60** is attached to the main body **12** by a non-illustrated fixing means. The valve gear **48** enmeshes with the motor gear **50** that is attached to an output shaft **58***a* of the stepping motor **58**, and rotates in conjunction with the output shaft **58***a* of the stepping motor **58**. The valve gear **48** and the motor gear **50** are arranged on an upper surface of the support frame **60**. The valve gear **48** is made up from a gear portion **48***a* having teeth on the outer circumference thereof, and a shaft portion **48***b* that protrudes downward from the gear portion **48***a*. The gear portion **48***a* and the shaft portion **48***b* include a central hole **48***c* that penetrates in the X direction, which is the axial direction thereof. An inner circumference of the gear portion **48***a* is equipped with the splines **48***d* that engage with the splines **44***d* of the stem **44** (see FIG. **4**).

The support frame **60** includes an insertion hole **60***a* into which the feed screw **42** and the stem **44** are inserted. An upper part of the insertion hole **60***a* is formed with an enlarged diameter that serves as a first recess **60***b* for supporting the shaft portion **48***b* of the valve gear **48**. A lower part of the insertion hole **60***a* has a diameter that is enlarged stepwise, and forms a second recess **60***c* into which the upper end part of the valve seat body **28** is inserted. The shaft portion **48***b* of the valve gear **48** is inserted into the first recess **60***b*. A convex portion **48***e* provided on an upper surface of the gear portion **48***a* abuts against the cover **14**. Due to this feature, the valve gear **48** is supported so as to be capable of rotating about the central axis, while movement thereof in the X direction, which is the axial direction, is restricted. The support frame **60** is positioned in the interior of the accommodating chamber **40** by fitting the upper end part of the valve seat body **28** into the second recess **60***c* of the support frame **60**.

The cylindrical portion **44***b* of the stem **44** is inserted into the central hole **48***c* of the valve gear **48** and the insertion hole **60***a* of the support frame **60**. When the stem **44** is moved downward by pushing down on the handle **56**, the splines **44***d* of the stem **44** engage with the splines **48***d* of the valve gear **48**. Consequently, the driving force of the stepping motor **58** is transmitted to the feed screw **42** via the motor gear **50**, the valve gear **48**, and the stem **44**. On the other hand, when the stem **44** is moved upward by pulling the handle **56** upward, engagement between the splines **44***d* of the stem **44** and the splines **48***d* of the valve gear **48** is released.

A circuit board **62**, which is perpendicular with respect to the support frame **60**, is disposed in the accommodating chamber **40**. Electronic components in order to drive the stepping motor **58** are mounted on the circuit board **62**. Needle-shaped terminals **64** that are erected on the circuit board **62** extend to the inner side of a tubular connector portion **66** provided on a side surface of the main body **12**. Non-illustrated wirings are provided between the circuit board **62** and the stepping motor **58**. The stepping motor **58** is driven by a remote control signal supplied from the terminals **64**.

The flow rate adjusting valve **10** according to the present embodiment is configured in the manner described above. Hereinafter, descriptions will be given concerning a case in which the valve opening degree is adjusted by remote control, and a case in which the valve opening degree is manually adjusted. As shown in FIG. **4**, the state in which the handle **56** is in the upper limit position is regarded as an initial state.

For driving the stepping motor **58** by remote control to thereby adjust the valve opening degree, the handle **56**, which is at the upper limit position, is pushed down to the lower limit position. As shown in FIG. **5**, when the handle **56** is pushed downward, initially, the engagement between the first splines **56***f* of the inner tubular portion **56***c* of the handle **56** and the splines **46***a* of the handle holder **46** is released, and the stem **44**, which is integral with the handle holder **46**, is released from the connected state with the handle **56**. More specifically, the motive power transmission path between the handle **56** and the needle valve **34** is interrupted midway, i.e., interrupted between the handle **56** and the handle holder **46**. Moreover, an appropriate frictional force is applied at a location where the upper end part of the feed screw **42** is fitted into the cylindrical portion **44***b* of the stem **44**, or alternatively, at a location where the cylindrical portion **44***b* of the stem **44** is inserted through the central hole **48***c* of the valve gear **48**. Therefore, when the handle **56** is pushed down, the stem **44** does not move downward immediately.

Further, substantially at the same time that the engagement between the first splines **56***f* of the handle **56** and the splines **46***a* of the handle holder **46** is released, the second splines **56***g* of the inner tubular portion **56***c* of the handle **56** start to engage with the splines **16***d* of the handle supporting member **16**, and a state is brought about in which rotation of the handle **56** is prevented.

In addition, when the handle **56** is pushed down in close proximity to the lower limit position, the stem **44** is pushed down by the flange **56***e* of the handle **56**, and the splines **44***d* of the stem **44** engage with the splines **48***d* of the valve gear **48** (see FIG. **1**). Consequently, a state is brought about in which the driving force of the stepping motor **58** is capable of being transmitted to the needle valve **34** via the motor gear **50**, the valve gear **48**, the stem **44**, and the feed screw **42**. More specifically, the motive power transmission path between the stepping motor **58** and the needle valve **34** becomes continuous.

As noted previously, when the handle **56** is pushed down, a state is brought about in which the motive power transmission path between the handle **56** and the needle valve **34** is interrupted midway and rotation of the handle **56** is prevented. If the handle **56** is further pushed down to the lower limit position, the motive power transmission path between the stepping motor **58** and the needle valve **34** becomes continuous. In such a state, the stepping motor **58** can be driven by remote control, thereby causing the needle valve **34** to be moved in the axial direction, and enabling the valve opening degree to be adjusted.

Next, in order to manually adjust the valve opening degree, the handle **56** which is at the lower limit position is pulled upward to the upper limit position. As shown in FIG. **6**, when the handle **56** is pulled upward, initially, the first splines **56***f* of the inner tubular portion **56***c* engage with the splines **46***a* of the handle holder **46**, and the three constituent elements, i.e., the handle **56**, the handle holder **46**, and the stem **44**, are integrally connected in the direction of rotation. Owing to this feature, the motive power transmission path between the handle **56** and the needle valve **34** becomes continuous. Incidentally, the engagement between the second splines **56***g* of the inner tubular portion **56***c* and the splines **16***d* of the handle supporting member **16** cannot be released unless the handle **56** is pulled upward to a portion in close proximity to the upper limit position. Therefore, at this point in time, the handle **56** cannot be rotated.

Subsequently, when the handle **56** is pulled upward to a position in close proximity to the upper limit position, the handle holder **46** is pushed up by the flange **56***e* of the handle **56**. Consequently, the engagement between the splines **44***d* of the stem **44**, which moves integrally with the handle holder **46**, and the splines **48***d* of the valve gear **48** is released (see FIG. **4**). Further, the engagement between the second splines **56***g* of the inner tubular portion **56***c* of the handle **56** and the splines **16***d* of the handle supporting member **16** is released. By the engagement between the splines **44***d* of the stem **44** and the splines **48***d* of the valve gear **48** being released, the motive power transmission path between the stepping motor **58** and the needle valve **34** is interrupted midway.

Accordingly, if the handle **56** is pulled upward to the upper limit position, a situation is brought about in which the handle **56** can be manually rotated. Therefore, by rotating the handle **56**, the needle valve **34** can be moved in the axial direction via the handle holder **46**, the stem **44**, and the feed screw **42**, and the valve opening degree can be adjusted.

A case is assumed in which, while an on-site worker is pulling the handle **56** upward, prior to the engagement between the splines **48***d* of the valve gear **48** and the splines **44***d* of the stem **44** being released, the stepping motor **58** is driven by a remote control signal, and such a driving force is transmitted to the handle **56** by way of the stem **44**. Even in such a case, the second splines **56***g* of the inner tubular portion **56***c* of the handle **56** are engaged with the splines **16***d* of the handle supporting member **16**. Therefore, the handle **56** does not rotate unexpectedly, and the safety of an operator who is gripping the handle **56** is assured.

In accordance with the flow rate adjusting valve **10** according to the present invention, there is provided the motive power transmission mechanism that selectively switches between the rotational operating force of the handle **56** and the driving force of the stepping motor **58**, and transmits the selected force to the needle valve **34**. Therefore, regardless of the specifications of the stepping motor **58**, manual operation of the handle can be easily realized, and the safety of on-site workers is assured. Further, since the aforementioned switching can be performed by a push-pull operation of causing the handle **56** to be moved in the direction of the axis of rotation, ease of operation is satisfactory.

The present invention is not limited to the above-described embodiment, and various configurations can be adopted therein without departing from the essence and gist of the present invention as set forth in the appended claims.

What is claimed is:

1. A flow rate adjusting valve in which a needle valve is arranged so as to face a fluid passage of a main body, the flow rate adjusting valve comprising:

a handle configured to enable a rotational operation to be performed manually;

an electric motor configured to be operated remotely; and

a motive power transmission mechanism configured to selectively switch between a rotational operating force of the handle and a driving force of the electric motor, and to transmit the force to the needle valve,

wherein the switching is performed by causing the handle to be moved in a direction of an axis of rotation,

wherein:

the handle is configured to be moved along the axis of rotation of the handle in first and second directions that are mutually opposite to each other;

when the handle is pulled and moved in the first direction, a motive power transmission path between the handle and the needle valve is made continuous, and a motive power transmission path between the electric motor and the needle valve is interrupted midway; and

when the handle is pushed and moved in the second direction, the motive power transmission path between the handle and the needle valve is interrupted midway, and the motive power transmission path between the electric motor and the needle valve is made continuous, and

wherein:

each of the handle and a handle supporting member of the main body comprises splines, the splines of the handle and the splines of the handle supporting member being configured to be mutually engaged; and

when the handle is moved in the second direction from an end of movement in the first direction, the splines of the handle encase with the splines of the handle supporting member, whereby rotation of the handle is prevented.

2. The flow rate adjusting valve according to claim **1**, further comprising a cover configured to accommodate the electric motor and the motive power transmission mechanism in cooperation with the main body, wherein the cover includes a recess into which the handle enters when the handle is moved to an end of movement in the second direction.

3. The flow rate adjusting valve according to claim **1**, wherein:

the motive power transmission mechanism includes a feed screw configured to be screw-engaged with the needle valve,

rotation of the needle valve about a central axis is restricted;

movement of the feed screw in an axial direction is restricted; and

when the screw is rotated, the needle valve moves in the axial direction.

4. The flow rate adjusting valve according to claim **3**, wherein:

the motive power transmission mechanism includes a stem configured to move in an axial direction of the feed screw;

the feed screw rotates integrally with the stem; and

the rotational operating force of the handle and the driving force of the electric motor are transmitted to the needle valve via the stem and the feed screw.

5. The flow rate adjusting valve according to claim **4**, wherein:

when the handle moves in the first direction from an end of movement in the second direction, splines provided on the handle engage with splines provided on a handle holder fixed to the stem; and

when the handle moves in the second direction, the stem moves in a same direction, and splines provided on the stem engage with splines provided on a valve gear configured to operate in conjunction with an output shaft of the electric motor.

6. The flow rate adjusting valve according to claim **5**, wherein:

when the stem, which is integrated with the handle holder configured to be moved by abutment against the handle, abuts against a step portion provided on a handle supporting member, the handle reaches an end of movement in the first direction; and

when the handle abuts against an end part of the handle supporting member, the handle reaches the end of movement in the second direction.

7. The flow rate adjusting valve according to claim **6**, wherein:

when the handle reaches the end of movement in the first direction, a rib provided on the handle snap-engages with a first rib provided on the handle supporting member; and

when the handle reaches the end of movement in the second direction, the rib provided on the handle snap-engages with a second rib provided on the handle supporting member.

8. The flow rate adjusting valve according to claim **3**, wherein:

the needle valve is inserted and arranged inside a valve seat body fixed to the main body; and

a needle packing in sliding contact with the valve seat body is mounted on an outer circumference of the needle valve.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 11,506,301 B2
APPLICATION NO. : 17/452088
DATED : November 22, 2022
INVENTOR(S) : Yuta Oshima

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

In Column 10, Line 36, delete "encase" and insert --engage--.

Signed and Sealed this
Thirtieth Day of May, 2023

Katherine Kelly Vidal

Katherine Kelly Vidal
Director of the United States Patent and Trademark Office